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(54) [Title of Invention] Pneumatic radial tires

(57) [Abstract]

[Problem] To provide pneumatic radial tire with improved
lightweightedness, enhanced operational stability and excel-
lent high speed durability.

[The Means of Solution] Pneumatic radial tire which has the
following construction: At the outer side of the one layer
of angled steel cord belt layer 20 which is positioned at
the inside of the tread section 16, at least one sheet of
the belt reinforcing layer 22 is installed over all of the
tread section; this belt reinforcing layer is formed by
winding the strip containing fiber cord in the spiral form;
the steel cord angle of this belt layer is 40 ~ 70 degrees;
this belt reinforcing layer consists of the poly ethylene
terephthalate fiber cord or poly ethylene -2,6 - naphthalate
fiber cord; this fiber cord is double twist of a total den-
ier of 1000 ~ 6000 ; the twist factor is 0.1 ~ 0.5 and the
ratio of the primary twist number and the final twist number
is 1.5 ~ 2.5.
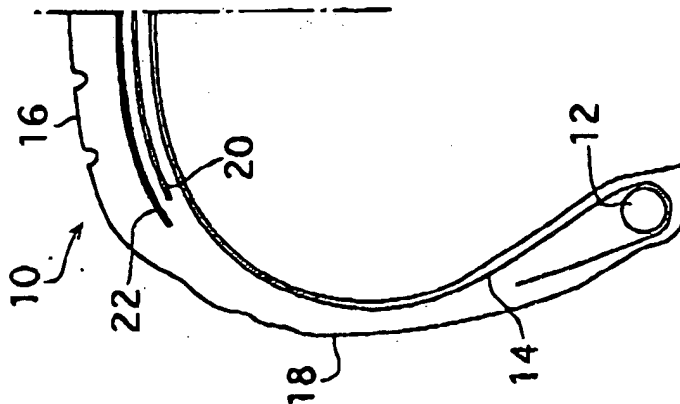
[Claims of the Patent]

[Claim 1] Pneumatic radial tire which is characterized by that,

in the pneumatic radial tire

which comprises a pair of bead sections, the carcass of extended toroidal shape mounted on the two bead sections, the tread section which is positioned at the crown section of the said carcass, and the sidewall section of the said carcass and

in which, at the outer periphery side of the one layer of angled steel cord belt layer that is positioned inside the said tread section, at least one sheet of the belt reinforcing layer is installed at least over the whole body of the tread section, the said belt reinforcing layer being formed by having the rubber strip of narrow width containing a plural number of fiber cords spirally wound such that the said cord is substantially parallel to the direction of tire circumference,

the steel cord angle of the said belt layer is 40 ~ 70 degrees from the direction of tire circumference, and

the fiber cord of the said belt reinforcing layer consists of the poly ethylene tere phthalate fiber cord or poly ethylene -2,6 - naphthalate fiber cord, and

the said fiber cord is of a double twist construction of a total denier of 1000 ~ 6000, and

the twist factor NT which is expressed by the following general equation (1) is 0.1 ~ 0.5, and also the ratio of primary twist to final twist, TR, which is expressed by the following general equation (2) is 1.5 ~ 2.5.

[Mathematical equation 1]

General equation (1)
$$NT = T \times (0.139 \times D \times 1/\rho)^{1/2} \times 10^{-3}$$

[where NT is the twist factor, T is the number of twist (times/ 10 cm), D is the total denier and ρ is the specific gravity, respectively]

[Mathematical equation 2]

General equation (2)
$$TR = PT/CT$$

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[where, TR is the ratio of primary twist to final twist, PT
is the number of primary twist (times/ 10 cm), CT is the
number of final twist (times/ 10 cm), respectively]

[Claim 2] The pneumatic radial tire described in Claim 1
which is characterized by that the said steel cord angle is
50 ~ 60 degrees.

[Claim 3] The pneumatic radial tire described in Claim 1
which is characterized by that the total denier of the said
fiber cord is 2000 ~ 4500 double twist.

[Claim 4] The pneumatic radial tire described in Claim 1
which is characterized by that the said twist factor NT is
0.15 ~ 0.35.

[Claim 5] The pneumatic radial tire described in Claim 1
which is characterized by that the said ratio of primary
twist to final twist, TR, is 1.7 ~ 2.2.

[Detailed Description of the Invention]

[0001]
[Field of Technology to Which the Invention Belongs] This
invention is related to the pneumatic radial tire which has
improved lightweightedness, enhanced operational stability
and excellent high speed durability.

[0002]
[Existing Technology] With the advances in vehicles toward
higher class and higher quality, the demand of improvement
on the tire's lightweightedness, operational stability and
high speed durability has been rising very high.

[0003] Currently, in the belt layer of the radial tires,
mainly the 2 sheets of angled steel belt are used. On the
other hand, in the belt reinforcing layer, mainly the double
twisted organic fiber cord like nylon is used and its twist
factor is made to be low twist to enhance the cord modulus
and to attempt to improve the operational stability and high
speed durability of the tires.

[0004] However, in such belt layer construction, to improve
the high speed durability, for example, the design ends up
with 2 layers of the belt layer and 1 layer of the belt re-
inforcing layer and a total of 3 layers and so the weight
increase can not be avoided. Also, if nylon fiber cord is
used in the belt reinforcing layer and the modulus is enhan-
ced, the adhesion between the cord and coating rubber drops
and so one can not see the improvement of high speed durabi-
lity matching with the improvement of tire rigidity. When

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one layer of angled steel belt is used for the weight
reduction, even if the existing nylon fiber cord is used in
the belt reinforcing layer to enhance the modulus even by
disregard-ing the adhesion, the rigidity is short to begin
with and the operational stability is lost.

[0005]
[The Problem Which the Invention Intends to Solve] Thereu-
pon, the objective of this invention is to provide the pneu-
matic radial tire with improved lightweightedness, enhanced
operational stability and high speed durability.

[0006]
[The Means for Solving the Problem] To solve the above desc-
ribed problem, the present inventors conducted extensive in-
vestigations, focusing on the belt layer construction, and
the material, shape, physical properties and fiber twisting
method of the fiber cord which is used in the belt reinforc-
ing layer and, as the result, found out that, by the follow-
ing means, the above described requirements can be satisfied
simultaneously and thus this invention was accomplished.

(1) The pneumatic radial tire of this invention is cha-
racterized by that

in the pneumatic radial tire

   which comprises a pair of bead sections, the carcass of
extended toroidal shape mounted on the two bead sections,
the tread section which is positioned at the crown section
of the said carcass, and the sidewall section of the said
carcass and

   in which, at the outer periphery side of the one layer of
angled steel cord belt layer that is positioned inside the
said tread section, at least one sheet of the belt reinforc-
ing layer is installed at least over the whole body of the
tread section, the said belt reinforcing layer being formed
by having the rubber strip of narrow width containing a
plural number of fiber cords spirally wound such that the
said cord is substantially parallel to the direction of tire
circumference,

the steel cord angle of the said belt layer is 40 ~ 70 deg-
rees from the direction of tire circumference, and

the fiber cord of the said belt reinforcing layer consists
of the poly ethylene tere phthalate fiber cord or poly
ethylene -2,6 - naphthalate fiber cord, and

the said fiber cord is of a double twist construction of a
total denier of 1000 ~ 6000, and

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the twist factor NT which is expressed by the following general equation (1) is 0.1 ~ 0.5, and also the ratio of primary twist to final twist, TR, which is expressed by the following general equation (2) is 1.5 ~ 2.5.

[0007]
[Mathematical equation 3]

General equation (1)
$$NT = T \times (0.139 \times D \times 1/\rho)^{1/2} \times 10^{-3}$$

[0008] [where NT is the twist factor, T is the number of twist (times/ 10 cm), D is the total denier and ρ is the specific gravity, respectively]

[0009]
[Mathematical equation 4]

General equation (2)
$$TR = PT/ CT$$

[0010] [where, TR is the ratio of primary twist to final twist, PT is the number of primary twist (times/ 10 cm), CT is the number of final twist (times/ 10 cm), respectively]

(2) The pneumatic radial tire of this invention is characterized by that, in the above described Section (1), the said steel cord angle is 50 ~ 60 degrees.

(3) The pneumatic radial tire of this invention is characterized by that, in the above described Section (1), the total denier of the said fiber cord is 2000 ~ 4500 double twist.

(4) The pneumatic radial tire of this invention is characterized by that, in the above described Section (1), the said twist factor NT is 0.15 ~ 0.35.

(5) The pneumatic radial tire of this invention is characterized by that, in the above described Section (1), the said ratio of primary twist to final twist, TR, is 1.7 ~ 2.2.

[0011] As for the fiber cord which is used in this invention, it is necessary to use polyethylene terephthalate fiber cord or polyethylene -2,6 - naphthalate fiber cord which has relatively high modulus, can easily satisfy the above said various properties and also has excellent performance for the tire requirement and is also economicaly ad-

vantageous. In particular, polyethylene terephthalate fiber cord is preferred.

[0012] In the pneumatic radial tire of this invention, at the side of outer periphery of the one layer of steel cord belt layer with an angle of 40 ~ 60 degrees, the belt rein-forcing layer is installed at least all over the tread sec-tion. The belt reinforcing layer is the strip of narrow width in which a plural number of cords are rubber-coated and this is wound endlessly in spiral form around the tire circumferential direction so that the strip is substantially parallel to the circumferential direction. Also, the belt reinforcing layer consists of polyethylene terephthalate or polyethylene -2,6-naphthalate fiber cord ; this fiber cord is the double twist of a total denier of 1000 ~ 6000 denier and the above said twist factor is 0.1 ~ 0.5 and also the said ratio of the primary twist to final twist is 1.5 ~ 2.5. In this way, one layer of steel belt layer is used to achie-ve lighter weight. Also, the belt reinforcing layer is wound in spiral form all over the tread section. As for the cord which is used in this reinforcing layer, the high modulus polyester fiber cord is used and the twist factor of the final twist is set such that the cord modulus would be at the maximum. By having the barrier-like reinforcing layer of high tension installed in the tire circumferential direc-tion, operational stability and high speed durability of the tire can be maintained at high level and, further, by opti-mizing the twist number to improve the adhesion of cord and rubber, the high speed durability of tire can be improved furthermore.

[0013] Unless the belt reinforcing layer has the above desc-ribed construction by the spiral winding, a joint is formed in the tire circumferential direction and so, rather than the tension in the circumferential direction improving, the slipping occurs between the upper and lower layers of the joint at the joint section and, even if the cord properties are limited as described above, the effect can not be seen.

[0014] In this invention, the steel cord angle of the belt layer is 40 ~ 70 degrees, preferably 50 ~ 60 degrees. By this, the operational stability of high level can be obtain-ed. If the angle is less than 40 deg or over 70 deg, it is not good for the operational stability.

[0015] In this invention, the fiber cord of the belt rein-forcing layer has a total denier of 1000 ~ 6000, preferably 2000 ~ 6000, in the double twist construction. If this is less than 1000 denier, it is not preferable from the view point of operational stability and, if it exceeds 6000 den-ier, it is not preferable from the view point of weight increase.

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[0016] In this invention, the fiber cord of belt reinforcing layer has a twist factor of 0.1 ~ 0.5, preferably 0.15 ~ 0.3. Thus, by having a low twist and raising the modulus of cord, the operational stability and high speed stability of tire can be kept at high level. If the twist factor exceeds 0.5, modulus of the cord drops and so this is not good. Also if it is less than 0.1, workability in tire making worsens and this is not suitable for the mass production

[0017] In this invention, for the fiber of the belt reinforcing layer, the ratio of the primary twist to final twist is 1.5 ~ 2.5, preferably 1.7 ~ 2.2. By this, even if the fiber cord has a low twist, the adhesion between this cord and rubber can be kept at adequate level and the high speed durability of tire improves further. If this ratio is less than 1.5, adhesion becomes inferior and this is not preferable. Also, if this ratio exceeds 2.5, this means the twist number increased and this leads to increased cost and severe drop in the cord modulus and the operational stability of tire also becomes poor.

[0018] As has been described above, the lightweightedness, operational stability and high speed durability can be simultaneously satisfied at high level by using an optimal steel angle of the one layer belt layer and the polyester fiber cord in the belt reinforcing layer with the said cord of optimal denier, optimal twist factor and optimal ratio of the primary twist to final twist.

[0019]
[Mode of Application of the Invention] Figures 1 ~ 5 show the cross section of the pneumatic radial tires of the examples of application of this invention and Fig. 6 shows the cross section of pneumatic radial tire of comparative example.

[0020]
[0020] In Fig. 1 ~ 6, the pneumatic radial tire 10 comprises the carcass 14 which is folded and linked around the bead core 12 from the inside of tire to the outside, the tread section 16 which is positioned at the crown section of the carcass 14, the sidewall section 18 of the carcass 14, the one layer belt layer 20 (2 layers only Fig. 6) which is positioned at the inside of the tread section 16 and the belt reinforcing layer 22 consisting of at least one sheet over at least the whole tread section at the side of outer periphery of this belt layer 20. In this belt reinforcing layer 22, the rubber-coated narrow-width strip containing a plural number of cords is wound endlessly in spiral form such that the said cord is substantially parallel (0 deg ~ 5 deg) to the tire circumferential direction. The belt reinforcing layer 22 protrudes to the outer side in the axial direction of the belt layer 20 but it does not have to pro-

trude out. For the carcass 14, the fiber cord is arranged in the direction which substantially intersects with the circumferential direction perpendicularly and it is constructed of at least one sheet of layer. In the said belt layer 20, the steel cord is arranged in a slanted angle of 40 deg ~ 70 deg relative to the circumferential direction (or the tire's equatorial plane). In Fig. 6, 2 sheets are overlapped such that the cords would intersect in different directions.

[0021] All of Fig. 1 ~ 6 show the examples of positioning the belt reinforcing layer 22. Fig. 1 is the cross section of tire in which, in the whole of tread section 16, at the side of outer periphery of the belt layer 20, at the serial (phonetic translation) side - anti-serial side, the belt reinforcing layer 22 is wound uniformly in one layer. Fig. 2 is the cross section of tire in which the belt reinforcing layer 22 is wound in one layer in all of the tread section 16 and, at the two end sections of its outer periphery side, the belt reinforcing layer 22 is wound in one layer. Fig. 3 is the cross section of tire in which the belt reinforcing layer 22 is wound in one layer in all of the tread section 16 and, at the center of the tread section at the side of its outer periphery, the belt reinforcing layer 22 is wound in one layer. Fig. 4 is the cross section of tire in which the belt reinforcing layer 22 is wound in one layer in all of the tread section 16 and then, at the two end sections of its outer periphery side, the belt reinforcing layer 22 is wound in 2 layers. Fig. 5 is the cross section of the tire in which the belt reinforcing layer 22 is wound in 2 layers in all of the tread section 16 and in one layer at the two end sections. Fig. 6 of the comparative example is the cross section of tire in which the belt reinforcing layer 22 is wound in one layer at the outer periphery side of the 2 layers of belt layer 20 in all of the tread section 16.

[0022] (1) The tires which were used in Examples of Application 1 ~ 4 and Comparative Examples 1 ~ 6 to be described later are as follows. The size of tire which was used was 205/ 65R15 of tubeless construction. Production of the tire was conducted at the vulcanization condition of 170 deg C x 13 minutes, and post cure inflation condition of internal pressure 2.5 kg/ cm2, 26 minutes.

[0023] As for the carcass, one sheet in which poly ethylene terephthalate cord of 1500 D/2 (1500 denier 2 yarn twisted) of twist number (primary twist x final twist) 40 x 40 (twists/ 10 cm) was used; number of ends of cord was 55.0 ends/ 5 cm.

[0024] For the belt layer, one sheet of the steel cord belt of 1 x 5 x 0.23 construction (2 sheets in Comparative Example 4) was placed and the angle of placement was the prescribed angle relative to the circumferential direction (68

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deg in left and right, respectively in Comparative Example
4) and, as for the number of ends, 40.0 ends/ 5 cm was used.

[0025] The belt reinforcing layer was wound in spiral form
at the outside of the belt layer at 0 ~ 5 deg relative to
the circumferential direction. Belt reinforcing layer was
positioned as shown in Fig. 1 (Comparative Example 4 is in
Fig. 6). At this time, as for the belt reinforcing layer,
one layer was wound in all of the tread section, the width
of belt reinforcing layer being 5 mm wider at the two ends
of the outer side of belt layer in the axial direction. As
for this reinforcing layer, the strip of narrow width of
about 5 ~ 20 mm was used and this was formed on the belt
layer by the above described method.

[0026] The poly ethylene terephthalate fiber cord which is
used in the belt reinforcing layer was obtained as follows.

[0027] The poly ethylene terephthalate polymer was obtained
as follows. 2 mols of terephthalic acid, 3 mols of ethylene
glycol and antimony trioxide as the catalyst (2×10^{-4} mols
with respect to the terephthalic acid) were charged in the
reaction vessel attached with a stirrer. The reactor was
purged thoroughly with nitrogen gas. After this, inside of
the reactor was pressurized with nitrogen gas to 1.8 kg/ cm2
and the reaction was carried out at 240 deg C. Approximately
theoretical amount of water and side products were removed
out of the system and, after this, poly condensation reac-
tion was conducted for 60 minutes at 40 mmHg / 255 deg C,
for 60 minutes at 15 mmHg / 270 deg C and at 1 mmHg / 275
deg C until the prescribed molecular weight was reached.
After the reaction was finished, cooling was done immediate-
ly in ice water. The sample which was quenched in ice water
after the completion of poly condensation reaction was cut
into the pellet of 2 mm ~ 3 mm. 5 g of this was placed in a
round bottom flask of 100 ml volume. After pulling vacuum
(0.1 mmHg), the round bottom flask was placed in an oil
bath. At 160 deg C and 30 rpm stirring speed, 2 hours of
crystallization and preliminary drying were conducted. After
this, at the temperature of (melting point - 18 deg C) of
each sample, solid phase polymerization was conducted for
the prescribed length of time while stirring at a speed of
30 rpm. Solid phase polymerization time was about 7 hours
when the polymer of intrinsic viscosity = 0.60 (weight aver-
age molecular weight = 5.5×10^4) was used at the beginning
of polymerization until the intrinsic viscosity = 0.98 (wt
av. molecular weight = 7.5×10^4 level) was reached at 237
deg C.

[0028] The poly ethylene terephthlatae obtained by the solid
phase polymerization (intrinsic viscosity 0.98) was spun
and, under the spinning die, quenching was done in the gas
atmosphere of 10 ~ 60 deg C (e.g. 25 deg C) and the spun

yarn was wound up at a spinning speed of 1500 ~ 6000 m/ min
(e.g. 4200 m/ min). Then, drawing was done to a draw ratio
of 1.2 ~ 2.30 (e.g. 1.21) to prepare the poly ethylene tere
phthalate raw yarn.

[0029] This raw yarn was adjusted to the prescribed total
denier, twist factor, primary twist/ final twist ratio to
obtain the twisted cord. This twisted cord was applied with
adhesive and given the heat treatment under the following
condition.

[0030] Adhesive was prepared as follows: Resorcin - poly
sulfide and the resorcin-excess resorcin - formaldehyde
condensation product were mixed in a solid content ratio of
20 : 100. Out of this, 18 parts of the solid content was
taken out and, to this, 9 parts of 28 % ammonia water was
added and water was added to make a total of 50 parts and
this was completely dissolved. Next, 50 parts of resorcin -
formaldehyde condensation product / latex (RFL) was added
and the resulting material was used. Here, RFL is the one
which was adjusted to the following composition and was
cured for over 48 hours.

Water	518.8 (wt parts)
Resorcin	11.0
Formalin (37 %)	16.0
Ammonium hydroxide (28 %)	10.0
Vinyl pyridine - styrene - butadiene copolymer latex (41 %)	244.0

First, the twisted cord was dipped in this adhesive and the
dry zone treatment temperature was set to 170 deg C and the
treatment time was set to 60 ~ 160 seconds. Also, the treat-
ment temperature of the heat setting zone and normalizing
zone treatment temperature was set to 250 ~ 265 deg C and
the treatment time was set to 60 ~ 170 seconds. Then the
heat set zone cord tension was set to 0.4 ~ 1.1 g/ d, nor-
malizing zone cord tension was set to the range of 0.03 ~
0.50 g/ d. After this, in the annealing zone, treatment
temperature was set at 150 ~ 180 deg C, treatment time at 30
~ 170 seconds, cord tension at 0.01 ~ 0.70 g/d and, by this,
the prescribed adhesive-treated cord could be obtained.

[0031] (2) The methods of various testing which are used in
the Examples of Application 1 ~ 4 and Comparative Examples 1
~ 6 to be described later are as follows.

o Operational stability test

The test tire of 205/ 65R15, internal pressure 2.0 kgf/ cm2,
rim size 6J-15 was mounted on 4 wheels of the automobile of

2000 cc displacement sedan type and the car was run on the operational stability evaluation test course.

[0032] Each test tire was mounted on a passenger car and, at a speed of 60 ~ 200 kg/ hr, the actual car feeling test was conducted. For the items of (i) Straight run safety, (ii) Cornering stability, (iii) Feel of rigidity, (iv) Handling, grading of 1 ~ 10 points were given and each item was aver- aged to obtain the evaluation point of the operational sta- bility. The evaluation was conducted by 2 professional drivers and the average of the evaluation points by the 2 persons was determined and, taking the control tire of Com- parative Example 1 as 0, the result was indicted by the index. As to the points, 10 was good, 1 was poor and a difference of more than 3 points was regarded as a clear difference.

o High speed durability test

Evaluation of high speed durability of tire was conducted by the step speed method under the US Specification FMVSS No. 109 test method. Thus, speed was increased every 30 minutes until a disorder occurred and the speed at the disorder was indicated by an index with the control tire of Comparative Example 1 taken as 100. A larger index means better high speed durability.

o Lightweightedness of tire

This is expressed by the tire weight.

[Example of Application 1] Steel cord which was use din the belt layer was 1 sheet and its angle was 60 degrees.

[0033] The poly ethylene terephthalate fiber cord (PET) which was used as the belt reinforcing layer fiber cord was primary-twisted by 24 twists/ 10 cm; two of these were put together and the final twist was given in reverse direction by 12 twist/ 10 cm. Total denier was 3000 and the ratio of primary twist number/ final twist number was 2.0 and twist factor was 0.2.

[0034] With the pneumatic radial tire having such belt layer construction and the fiber cord of belt reinforcing layer, the lightweightedness, operational stability and high speed durability of the tire were evaluated. Results are shown in Table 1.

[Examples of Application 2 ~ 4] Regarding Example of Appli- cation 1, as shown in Table 1, the belt layer construction and the numerical values of the various elements (total denier, ratio of primary twist number to final twist number,

twist factor) of the poly ethylene terephthalate fiber cord
were altered for Examples of Application 2 ~ 4. For the
tires which were obtained in the same manner as in Example
of Application 1, the various characteristics were evaluated
and the results are shown in Table 1.

[Comparative Examples 1 ~ 6] Regarding the examples of app-
lication, numerical values of at least one of the elements
of belt layer construction and the poly ethylene tere phtha-
late fiber cord was varied to outside of the claimed range
as shown in Table 1 for Comparative Examples 1 ~ 3 and 5 ~
6. Also, nylon fiber cord was used for Comparative Example
4. Regarding the tires which were obtained in the same man-
ner as in Example of Application 1, various characteristics
were evaluated and results are shown in Table 1.

[0035] [Table 1]

		EA 実施例				CE 比較例					
		1	2	3	4	1	2	3	4	5	6
1 ベルト層構造	スチールコードの枚数	1	1	1	1	1	1	1	2	1	1
2	スチールコードの角度 deg	60	60	60	60	60	60	60	68	20	80
3 コード	材質	PET	PET	PET	PET	PET	PET	PET	+N	PET	PET
4	総デニール (D)	3000	3000	3000	3000	3000	3000	500	2500	3000	3000
5	下撚り数上撚り数の比TR	2.0	2.5	2.5	1.5	1.0	3.0	2.0	1.0	2.0	2.0
6	撚り係数NT	0.2	0.2	0.1	0.3	0.2	0.2	0.2	0.6	0.2	0.2
7 タイヤ特性	操縦安定性 (指数)	+2	+1	+2	+1	0	-3	-5	0	-4	-4
8	高速耐久性 (指数)	103	103	102	103	100	102	104	100	98	104
9	重量比 (タイヤ重量 kg)	8.8	8.8	8.8	8.8	8.8	8.3	8.8	8.6	8.8	8.8

EA. Example of Application; CE. Comparative Examples
1 ~ 2. Belt layer construction; 1. Number of sheets of steel
cord; 2. Angle of steel cord (deg.);
3 ~ 6. Cord; 3. Material; 4. Total denier (D) ; 5. Ratio of
the primary twist number/ final twist number, TR; 6. Twist
factor NT;

7 - 9. Tire characteristics; 7. Operational stability
(index); 8. High speed durability (index); 9. Lightweighted-
ness (tire weight, kg);

[0036] As is shown in Table 1, with the pneumatic radial
tire of this invention, all of the lightweightedness, opera-
tional stability and high speed durability are found to be
well balanced and excellent.

[0037] As shown in Comparative Examples, with the radial
tire in which at least one item among the number of sheets
of steel cord of the belt layer, its angle, the total denier
of the belt reinforcing layer fiber cord, twist factor and
the ratio of primary twist number to final twist number is
outside the claimed range, some of the 3 characteristics of
the tire are found to be inadequate.

[0038]
[Effectiveness of the Invention] The pneumatic radial tire
of this invention, with the above described constitution,
has the excellent effect of improved tire lightweightedness,
enhanced operational stability and improved high speed dura-
bility.

[Brief Description of the Figures]

[Fig. 1] is the cross section showing an example of applica-
cation of the pneumatic radial tire of this invention.

[Fig. 2] is the cross section showing another example of ap-
plication of the pneumatic radial tire of this invention.

[Fig. 3] is the cross section showing another example of ap-
plication of the pneumatic radial tire of this invention.

[Fig. 4] is the cross section showing another example of ap-
plication of the pneumatic radial tire of this invention.

[Fig. 5] is the cross section showing another example of ap-
plication of the pneumatic radial tire of this invention.

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[Fig. 2] is the cross section showing a comparative example
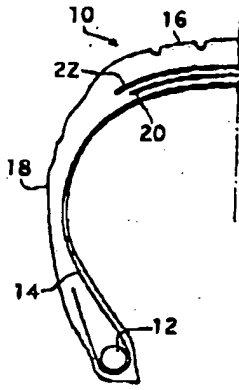the pneumatic radial tire.

[Description of the codes]

10 --- Pneumatic radial tire; 12 --- Bead core; 14 ---
Carcass; 16 --- Tread section; 18 --- Side wall section; 20
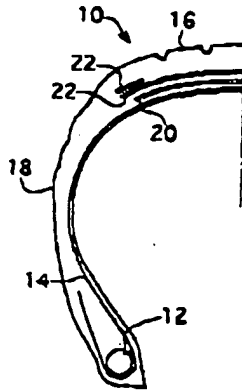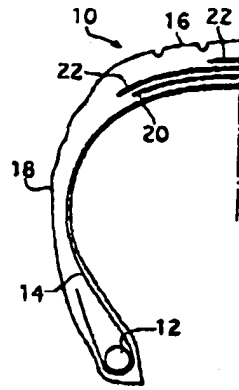--- Belt layer; 22 --- Belt reinforcing layer

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【図1】

【図2】

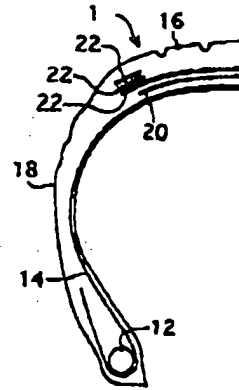【図3】

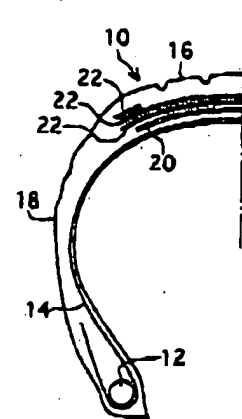【図4】

【図5】

【図6】